

ELECTRO HYDRAULIC CONTROL SYSTEM

Chapter 3.2

OBJECTIVES

1. Identify the purposes of the Electro Hydraulic Control (EHC) system.
2. Describe the significance of reactor pressure control to BWR operation.
3. Describe how the system accomplishes its purposes.

OBJECTIVES

4. Recognize the purpose of the following limiters:
 - a. Load Set
 - b. Load Limit
 - c. Maximum Combined Flow

OBJECTIVES

5. Recognize the purpose, function and operation of the following EHC system subsystems:
 - a. Pressure Control Unit
 - b. Speed Control Unit
 - c. Desired Load Control Unit
 - d. Valve Control Unit
 - e. Hydraulic Power Unit

OBJECTIVES

6. Given Figure 3.2-1, describe how the system operates to accomplish the following:
 - a. Normal steady state power operations
 - b. Power maneuvering
 - c. Plant shutdown and cooldown

OBJECTIVES

7. Describe how the EHC system interrelates with the following systems:
 - a. Main Steam
 - b. Condensate and Feedwater
 - c. Reactor Protection
 - d. Turbine Building Closed Loop Cooling Water

PURPOSE

The purposes of the EHC System are to:

- provide normal reactor pressure control by controlling steam flow consistent with reactor power
- control reactor pressure during startup, heatup, and cooldown evolutions,
- control the speed and electrical load on the turbine generator,
- provide protection for the main turbine, main generator and main condenser.

A BOILING WATER REACTOR WITHOUT EHC PRESSURE CONTROL

With the reactor operating stable at 100% power:

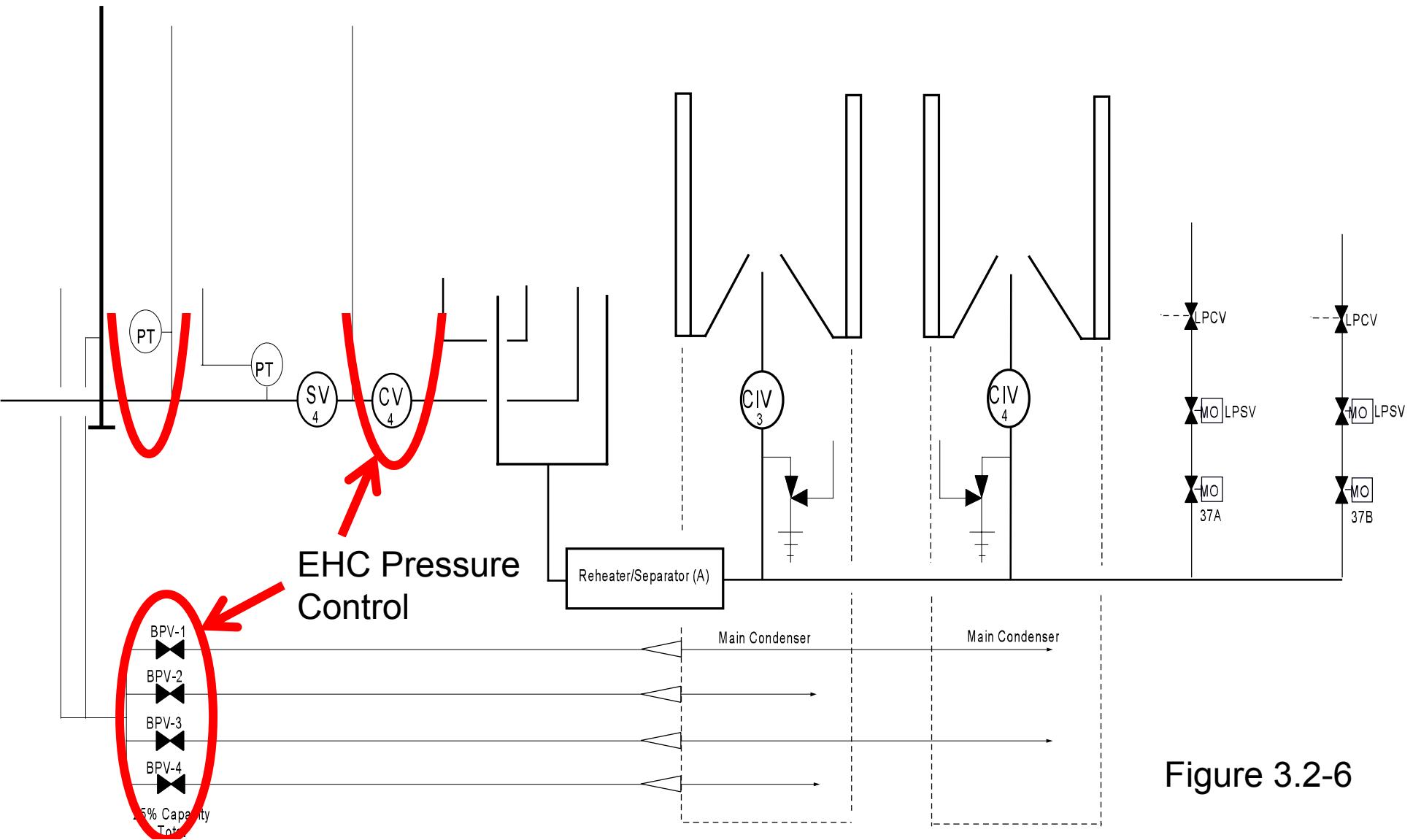
- A small reduction in main turbine load results in;
- A rise in reactor pressure which results in;
- A reduction in core voids which results in;
- A rise in reactor power which results in;
- A rise in reactor pressure which results in;
- A reduction in core voids which results in;
- A rise in reactor power which results in;
- Etcetera, etcetera, etcetera...

BOILING WATER REACTOR PRESSURE CONTROL

For this reason pressure control in a BWR slaves the turbine to the reactor

To reduce turbine load, you must FIRST reduce reactor power which results in;

- A reduction in reactor steam pressure which results in;
- Lower steam pressure sensed at the turbine which results in;
- The EHC regulator closing the turbine control valves to restore pressure which results in;
- A turbine load reduction and stabilized pressure.



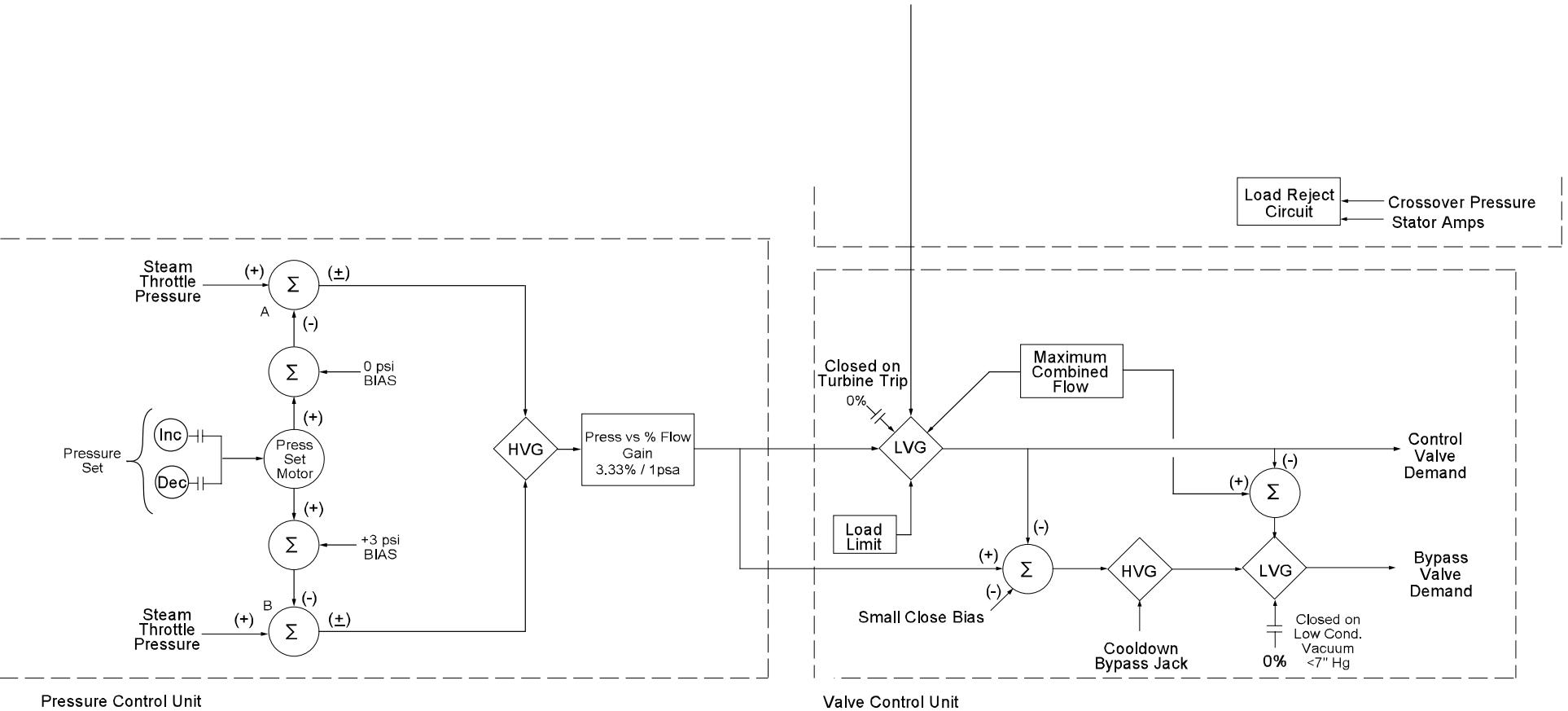


Figure 3.2-1

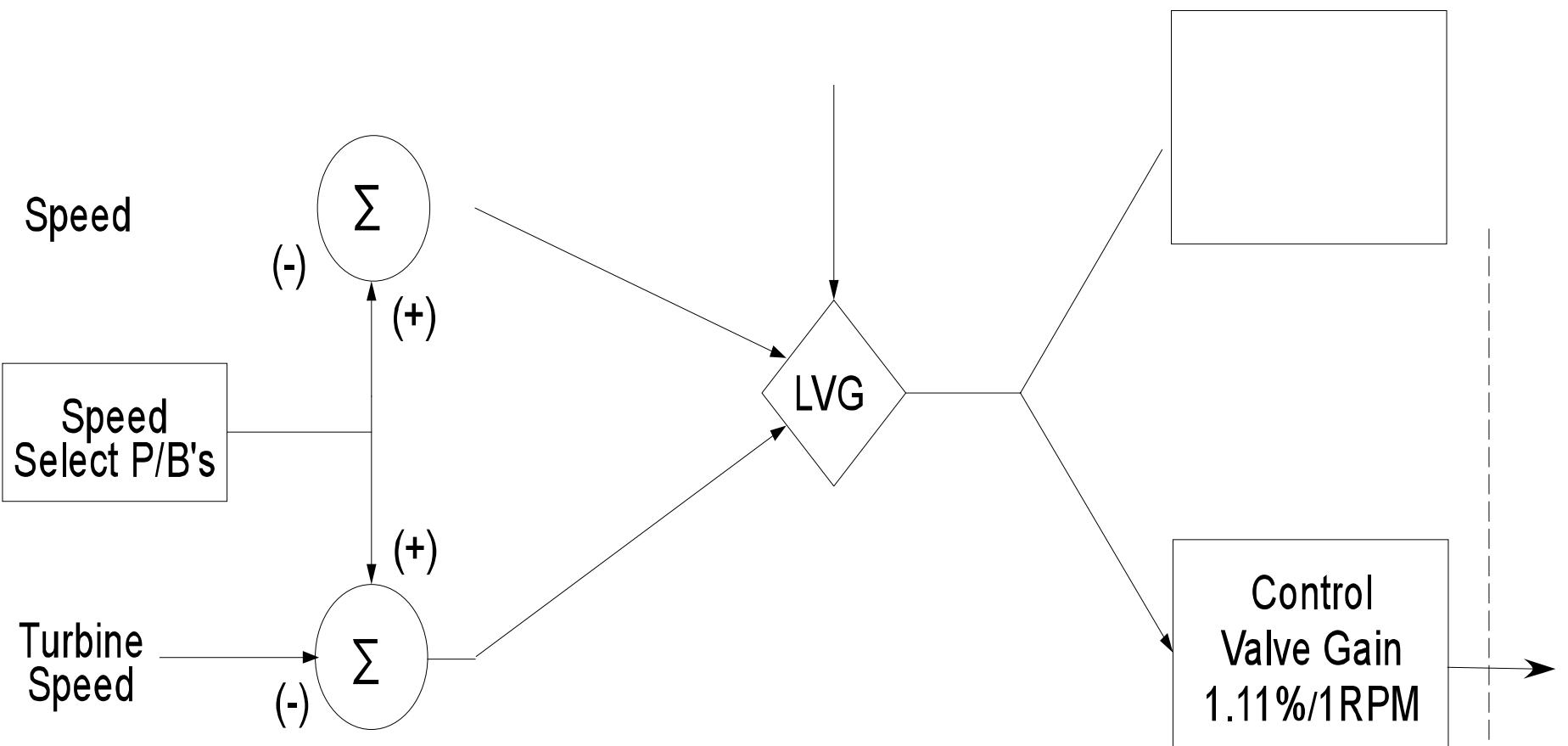


Figure 3.2-1c

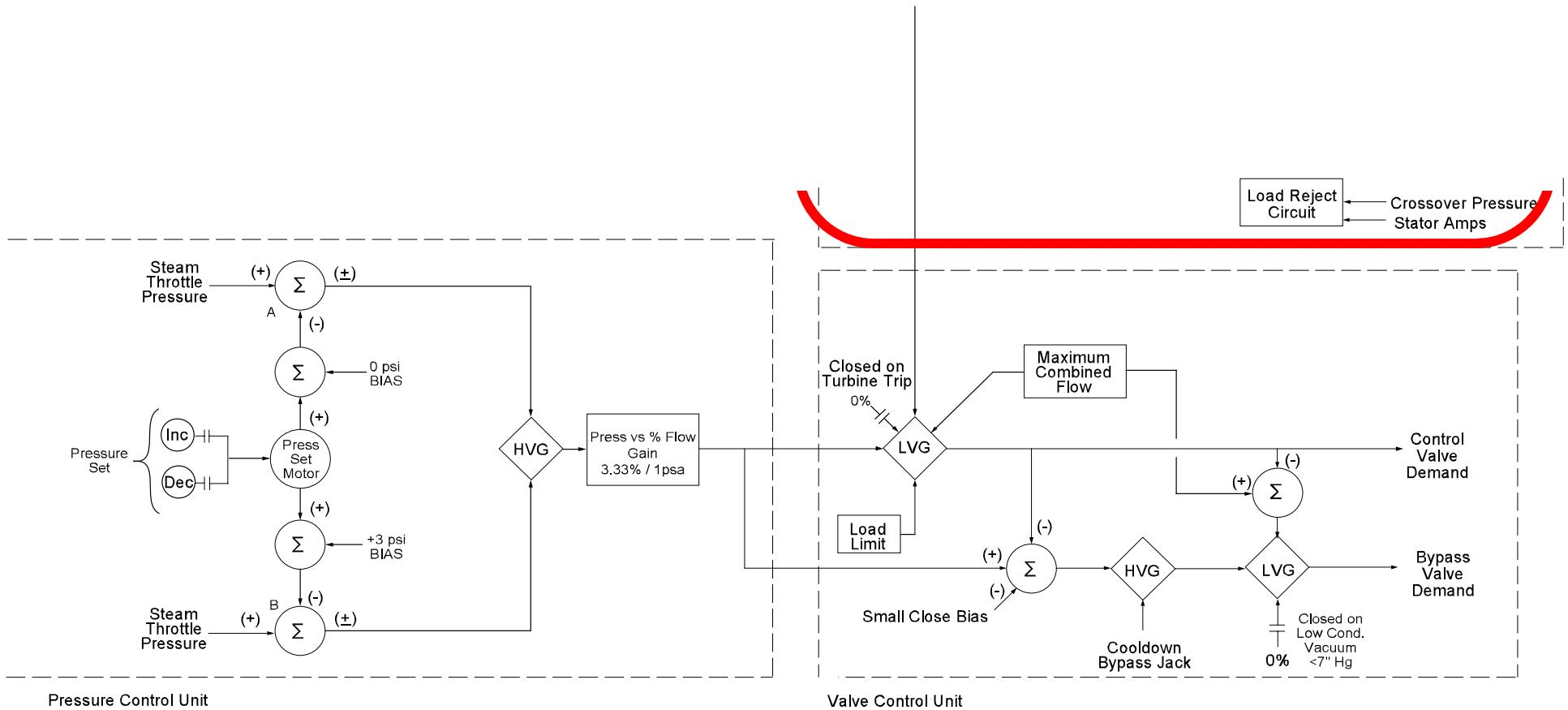


Figure 3.2-1

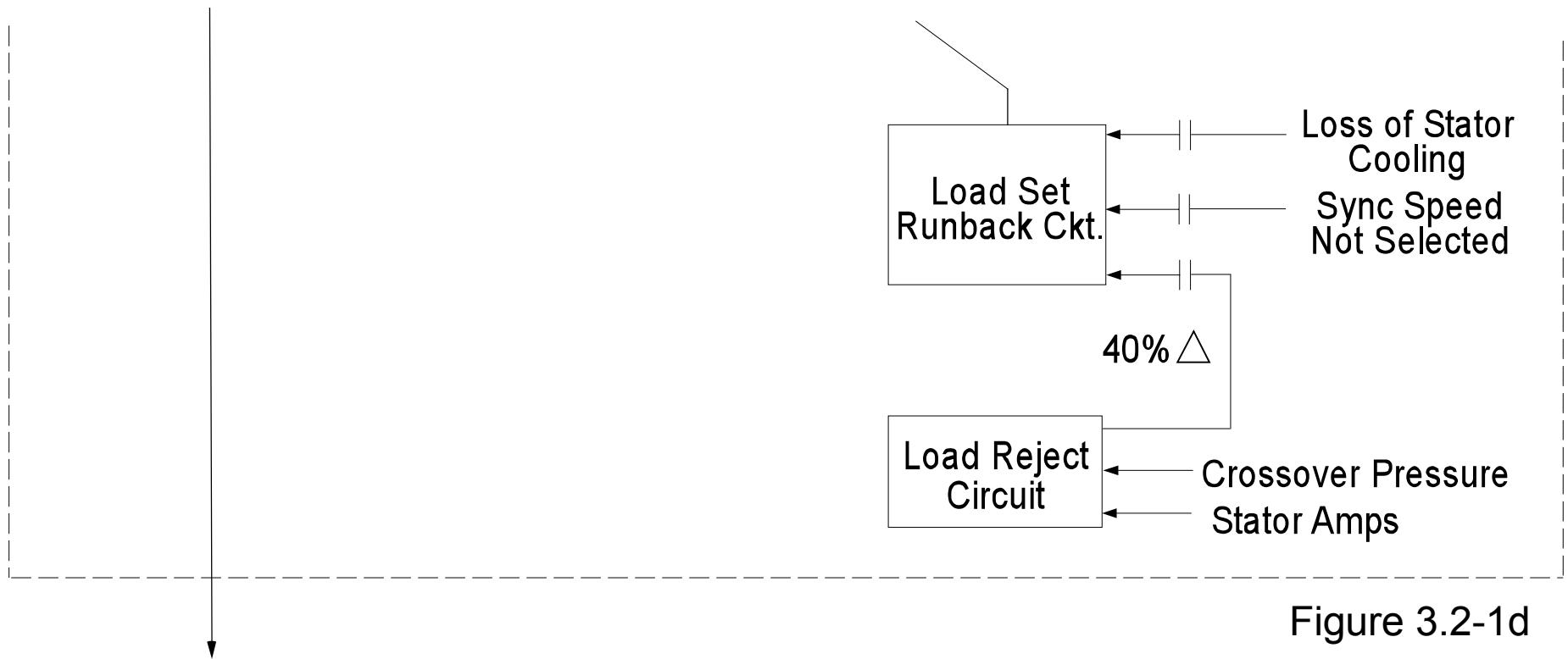


Figure 3.2-1d

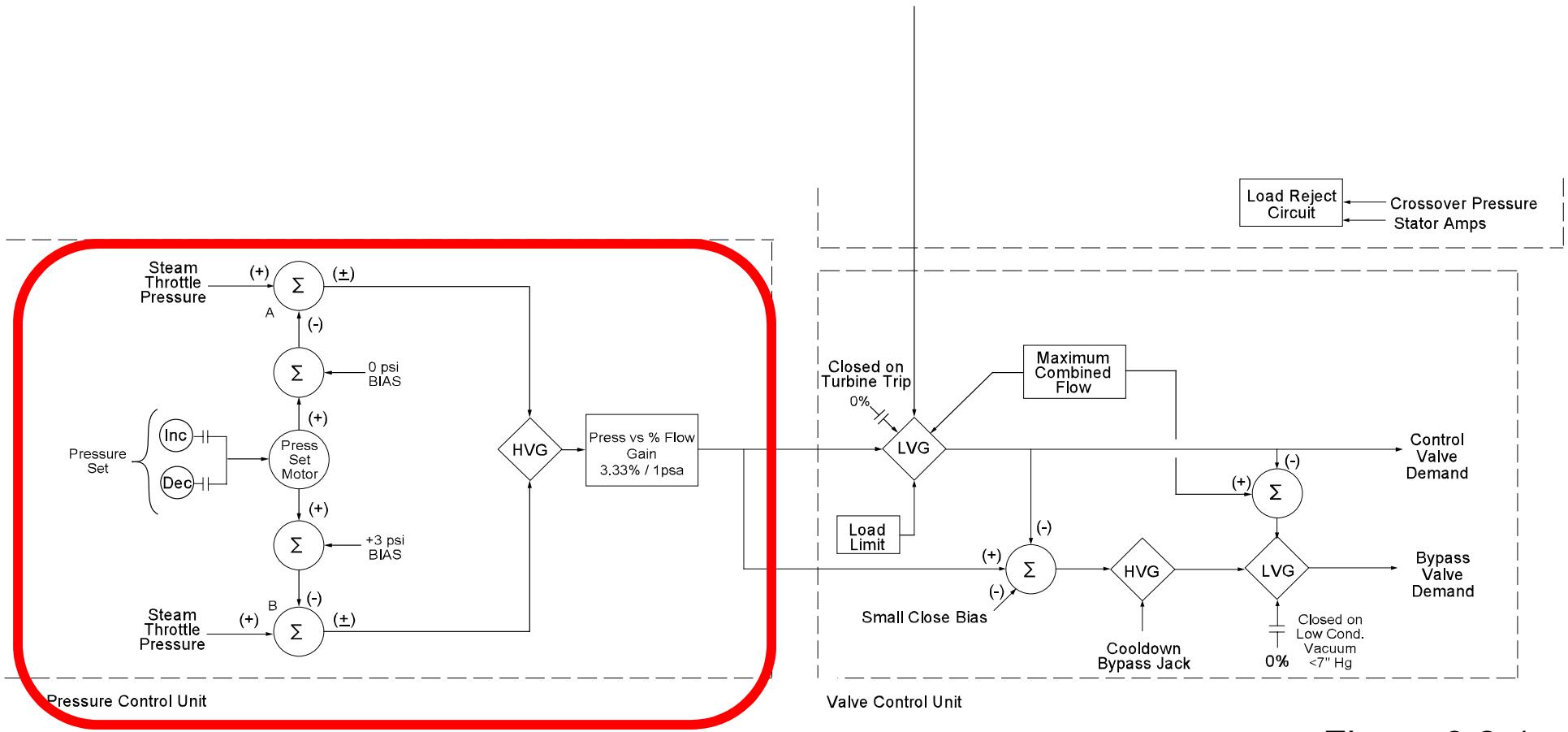
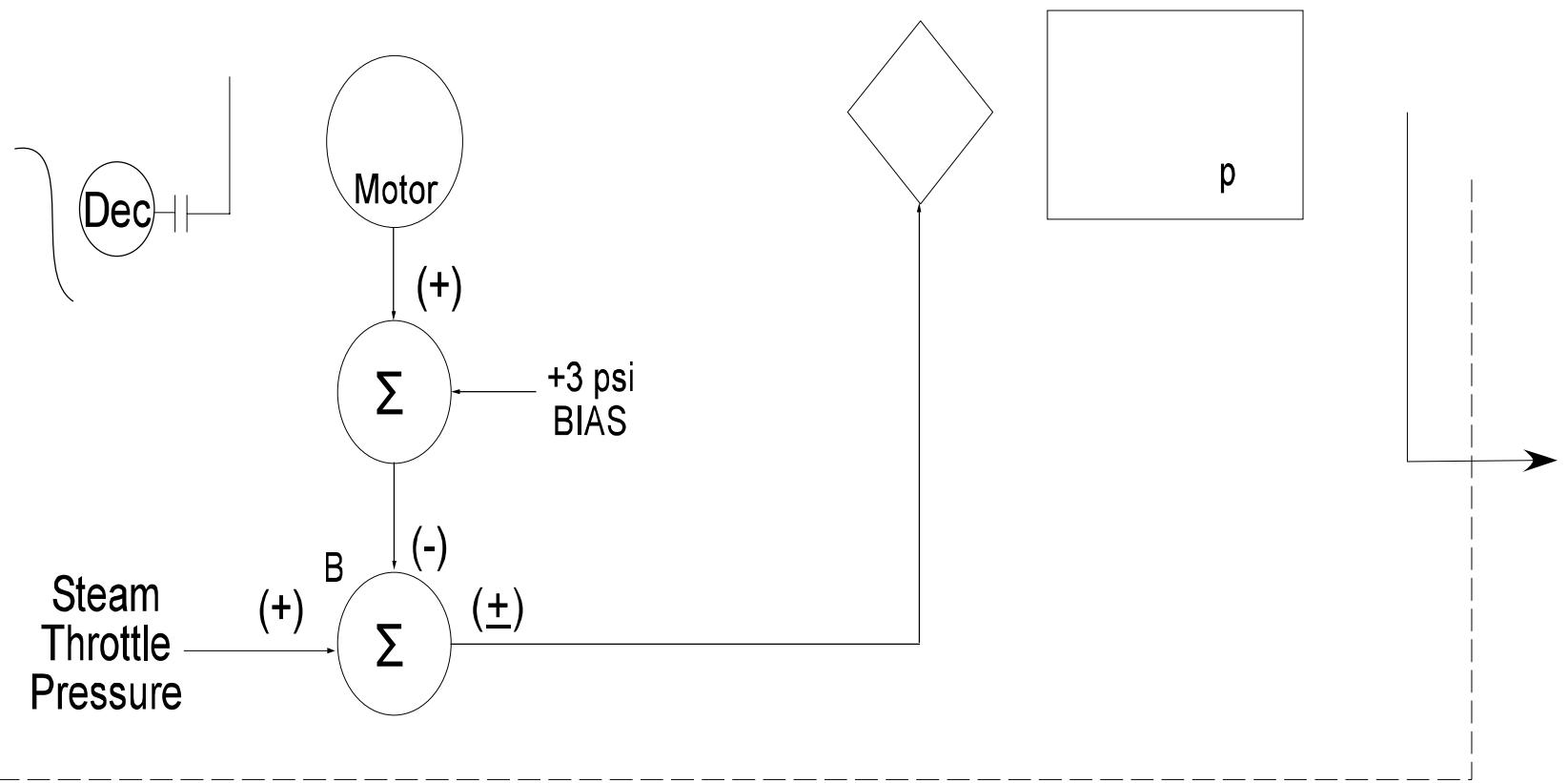


Figure 3.2-1



Pressure Control Unit

Figure 3.2-1a

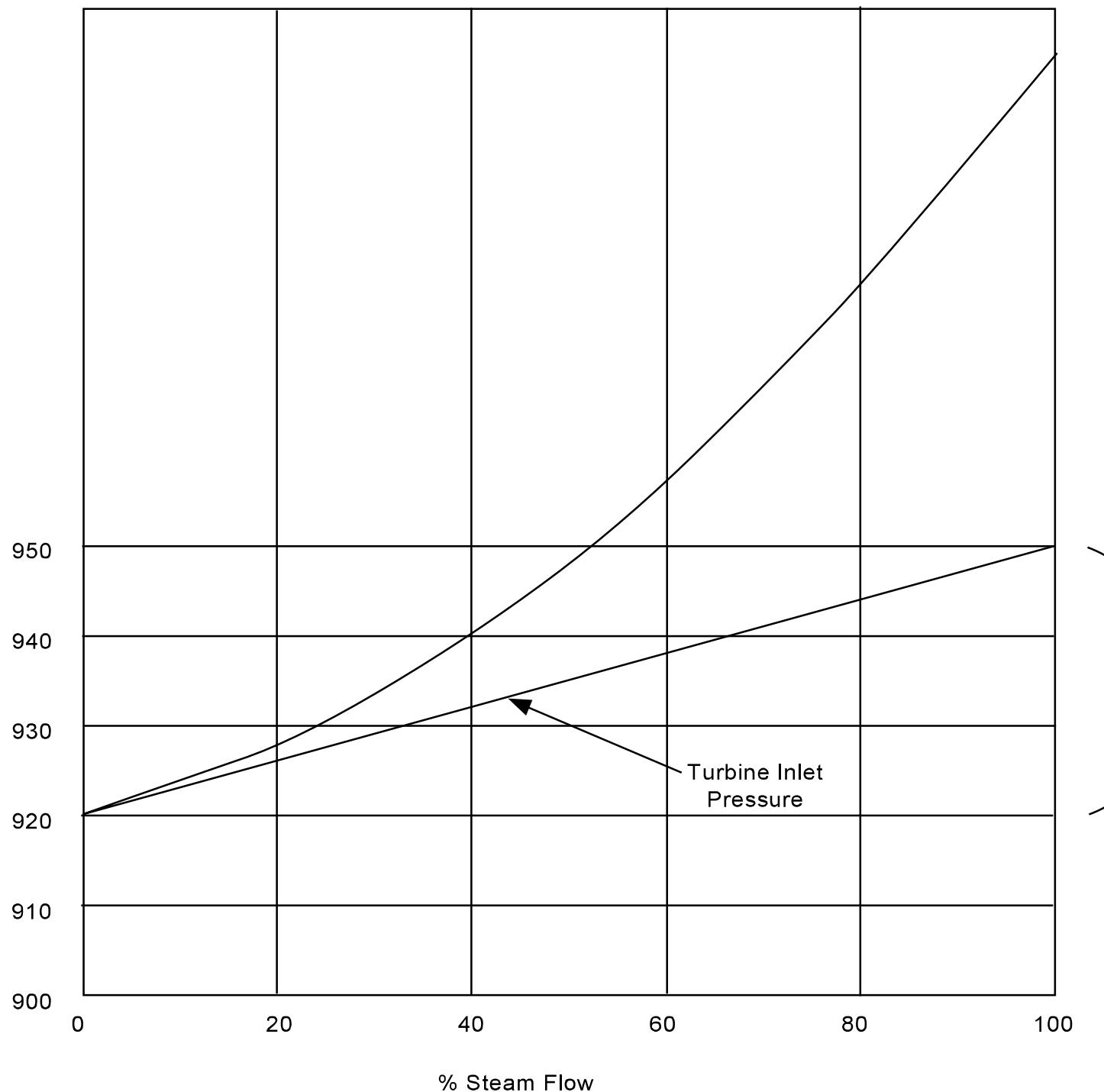


Figure 3.2-2

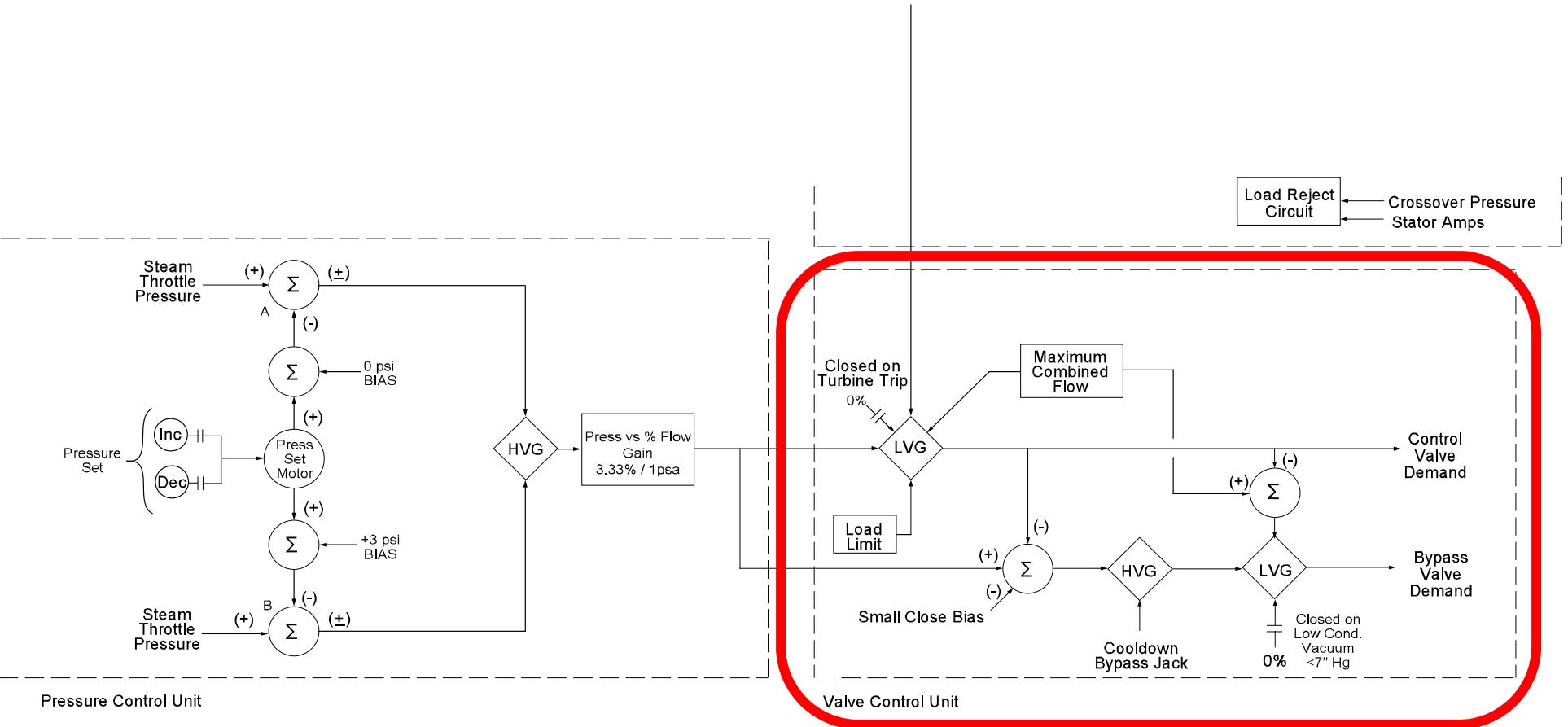
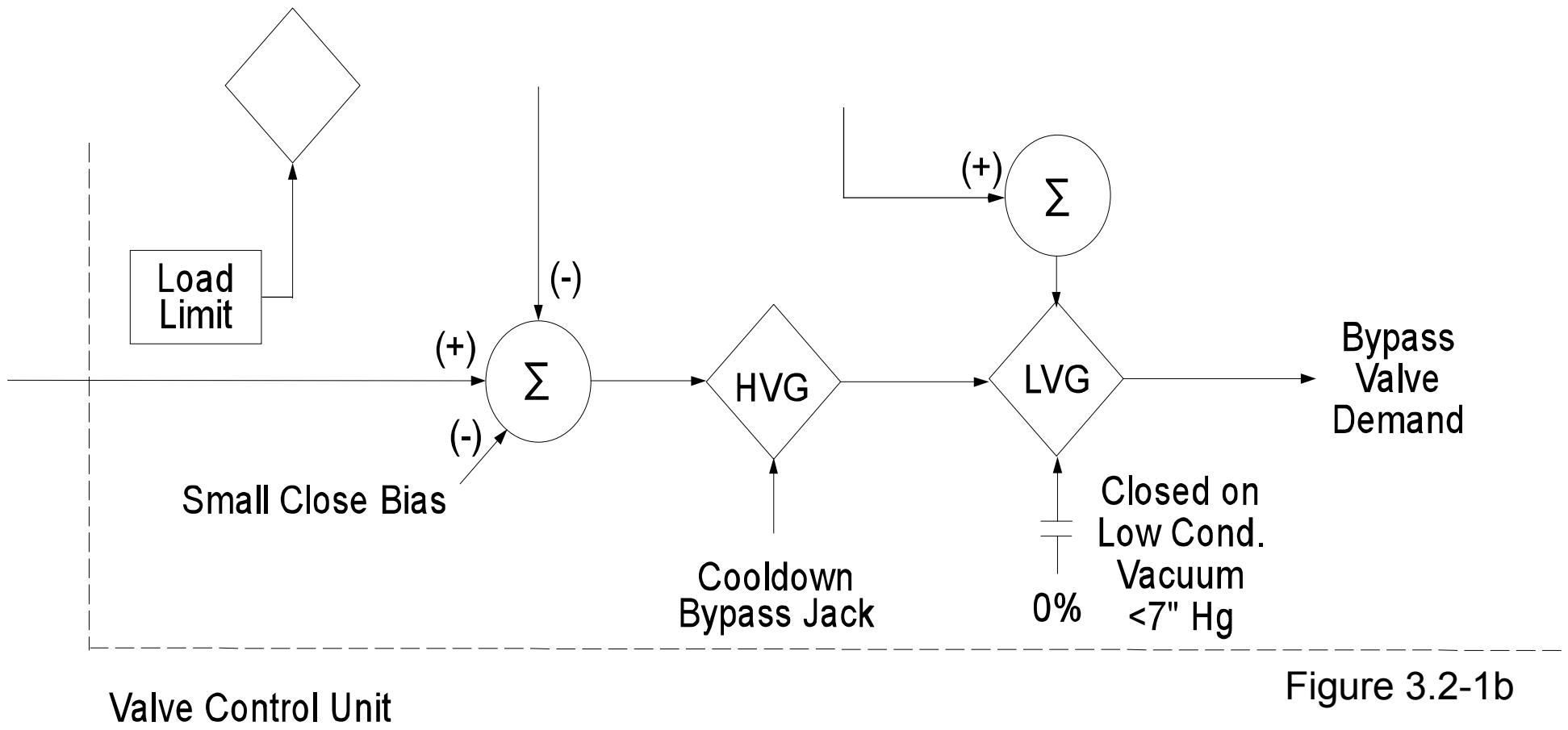


Figure 3.2-1



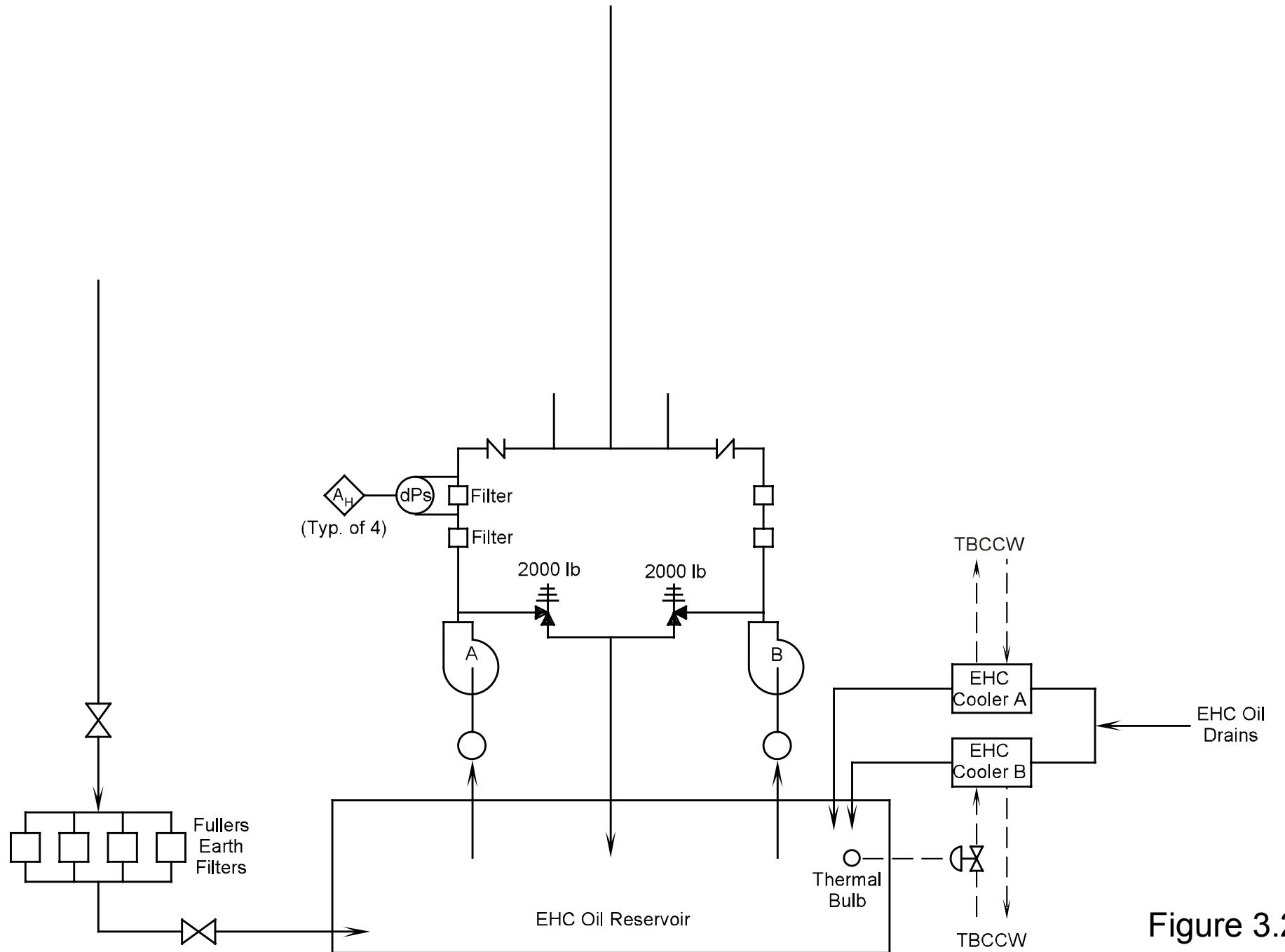


Figure 3.2-4

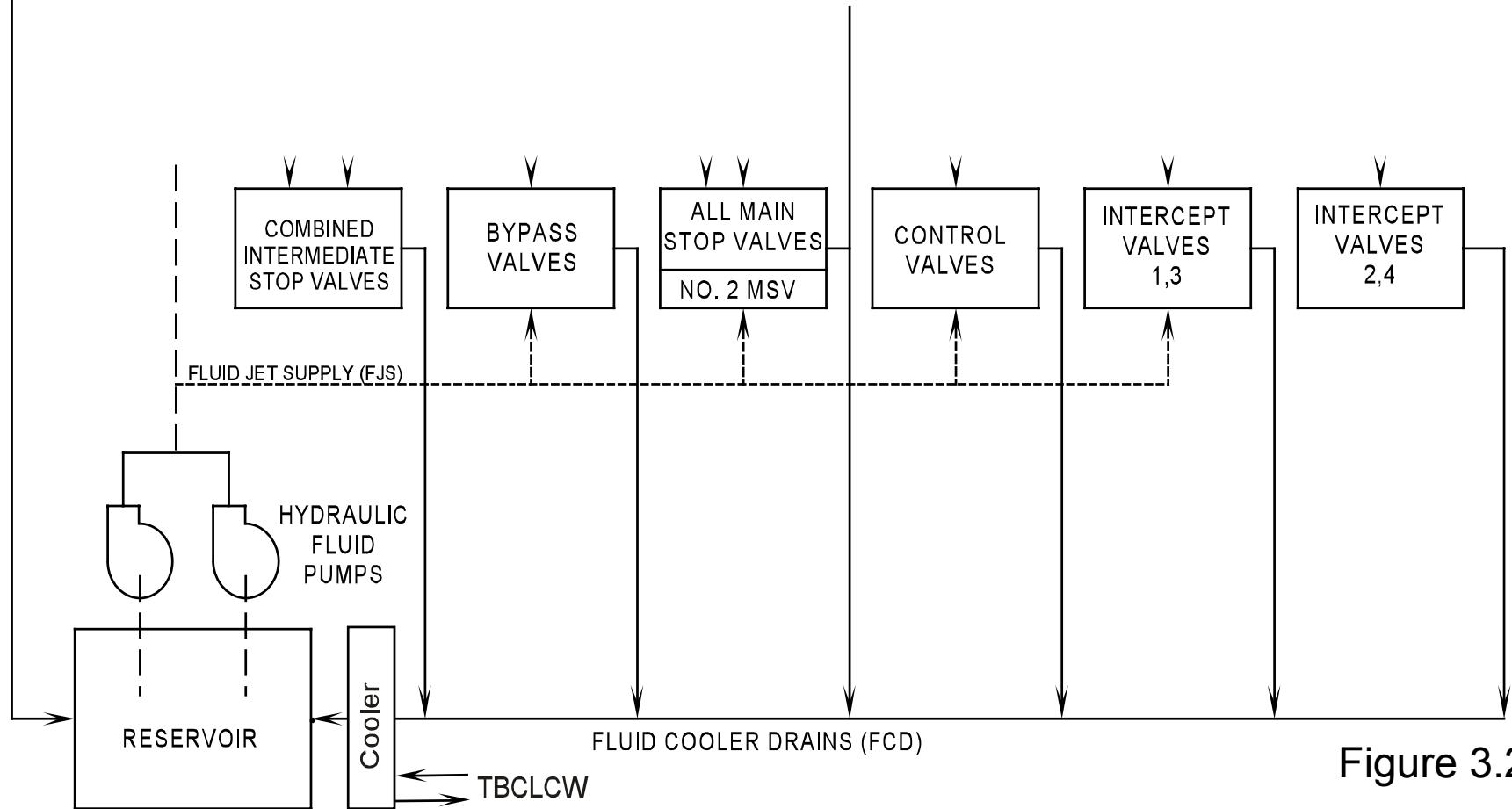
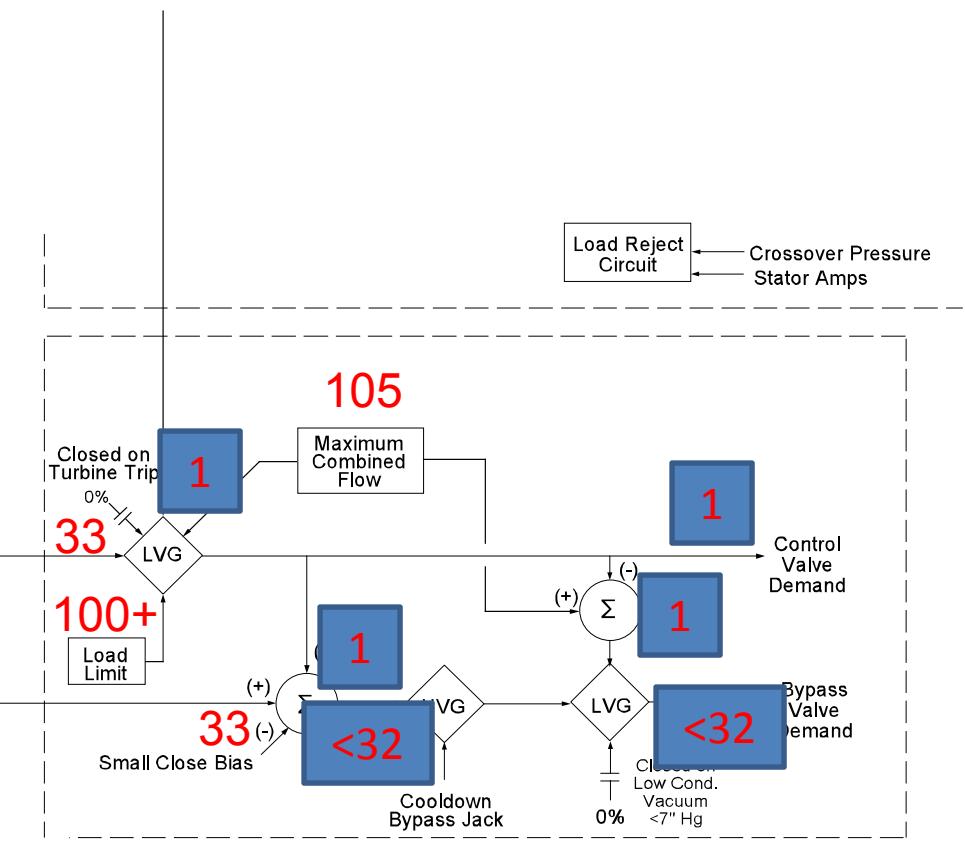
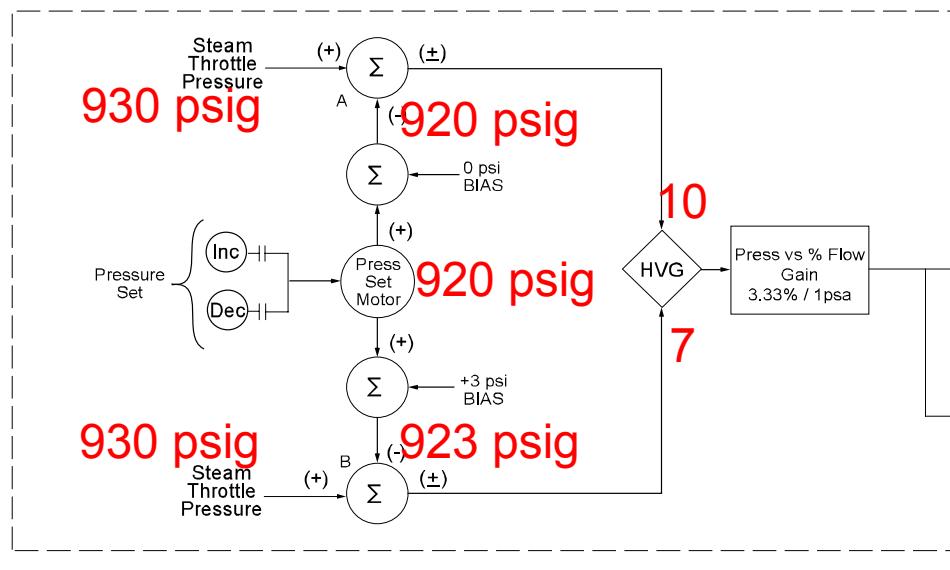


Figure 3.2-5

TABLE 3.2-1 Turbine Trip Conditions

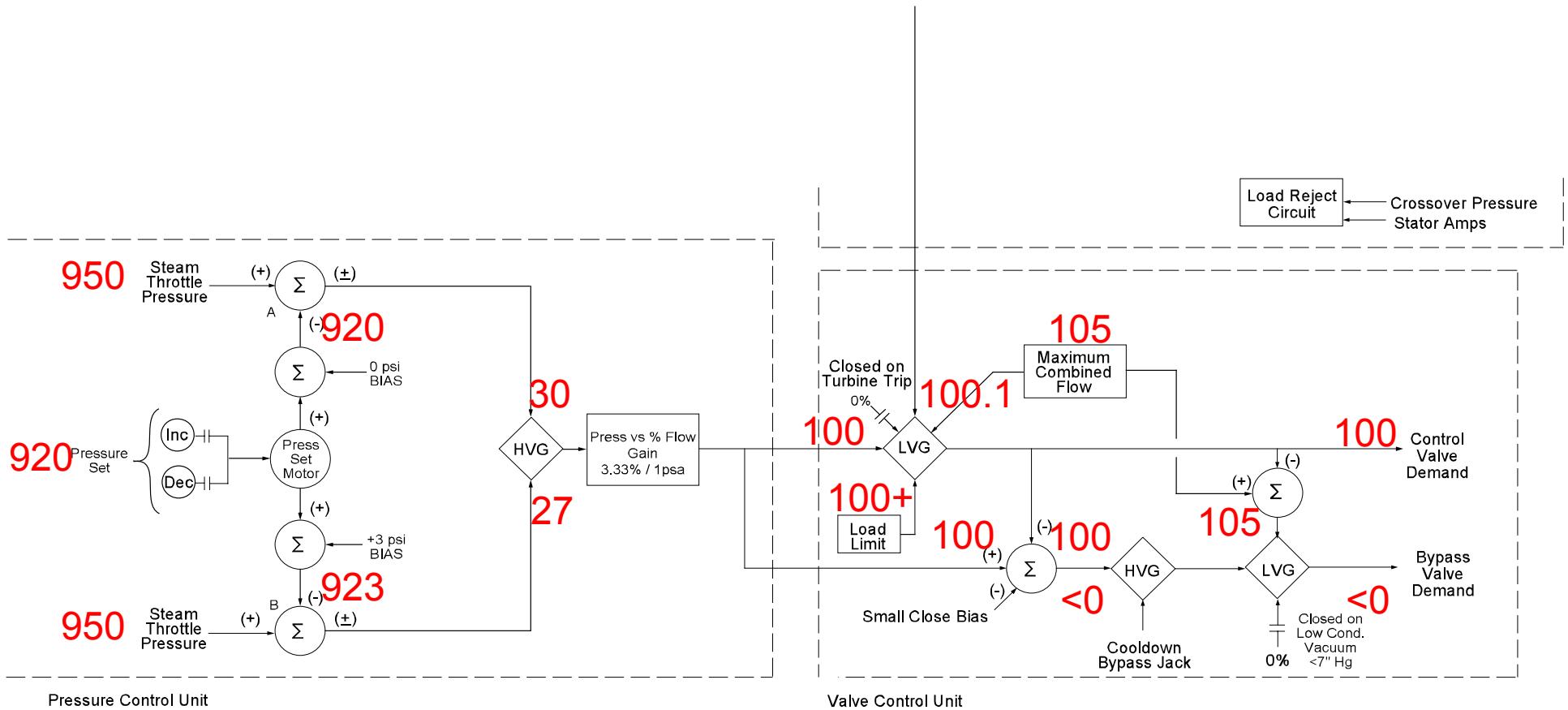
Trip	Setpoint and Reason
Reactor Vessel High Level	56.5" An excessively high water level could result in moisture carry over to the turbine resulting in blade erosion or damage.
EHC Fluid Header Pressure Low	<1100 psig Loss of EHC oil pressure would indicate a potential for no control since this is the hydraulic source for valve actuation.
Thrust Bearing Wear	~35 mils Indicates a potential misalignment between the diaphragms and buckets which could result in mechanical damage to the turbine.
Mechanical Overspeed Trip Backup Electrical Overspeed Trip	110/112% Indicates potential turbine damage due to excessive turbine speed and the resultant forces and misalignment.
Exhaust Hood High Temperature	225°F Excessive temperatures would result in thermal stress, damage to exhaust hood or potential misalignment.
Stator Cooling Failure	<13 psig or >95 °C Indicates operation of the generator under abnormal conditions. To prevent damage to the generator the turbine is tripped after a 70 second time delay if generator amps are >5811.
Low Main Shaft Oil Pump Pressure	<105 psig @ >1300 RPM A turbine trip is required to prevent bearing damage due to a loss of lubricating oil if turbine speed is >1300 RPM.
Low Bearing Oil Pressure	8 psig Prevent turbine damage due to loss of lubrication
Loss of Both Speed Feedback Channels to EHC Unit	Trips turbine because of potential overspeed condition if turbine speed is >200 RPM
Low Condenser Vacuum	22.5" Hg Indicates a loss of heat sink and operation of turbine at conditions for which it was not designed
Turbine/Generator High Vibration	10 mils vibration Anticipates turbine damage due to excessive

At 33% reactor power



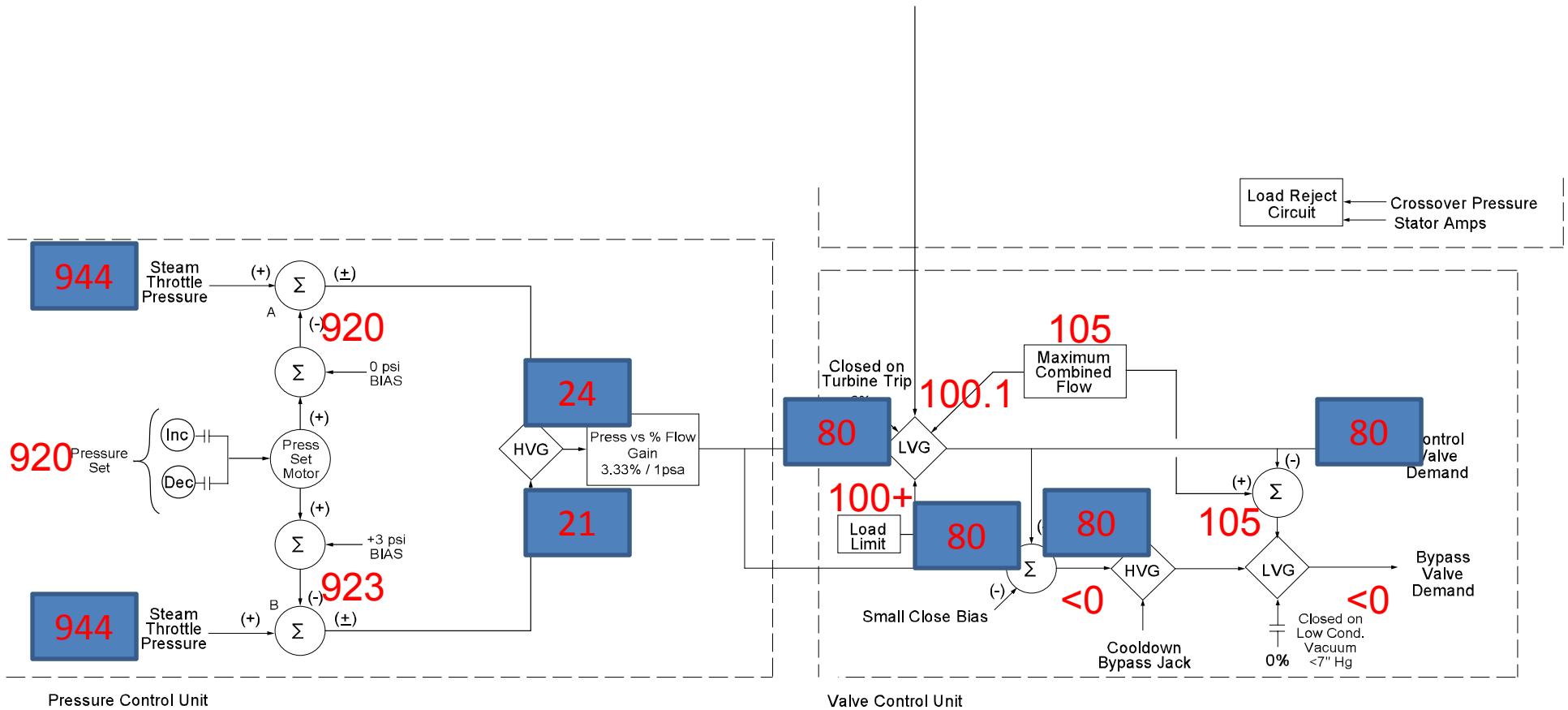
INITIAL TURBINE ROLL TO 1800 RPM

Figure 3.2-1

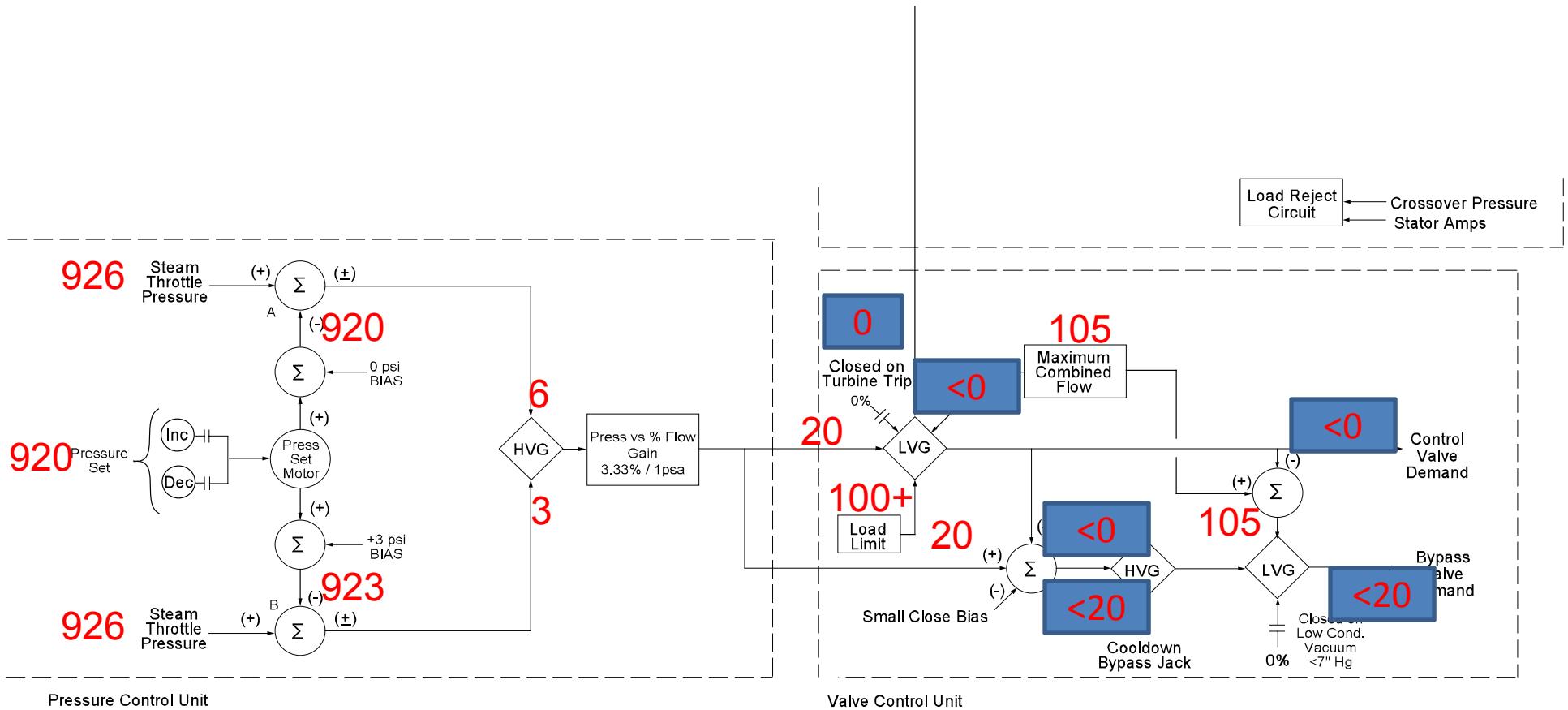


NORMAL STEADY STATE FULL POWER OPERATION

Figure 3.2-1

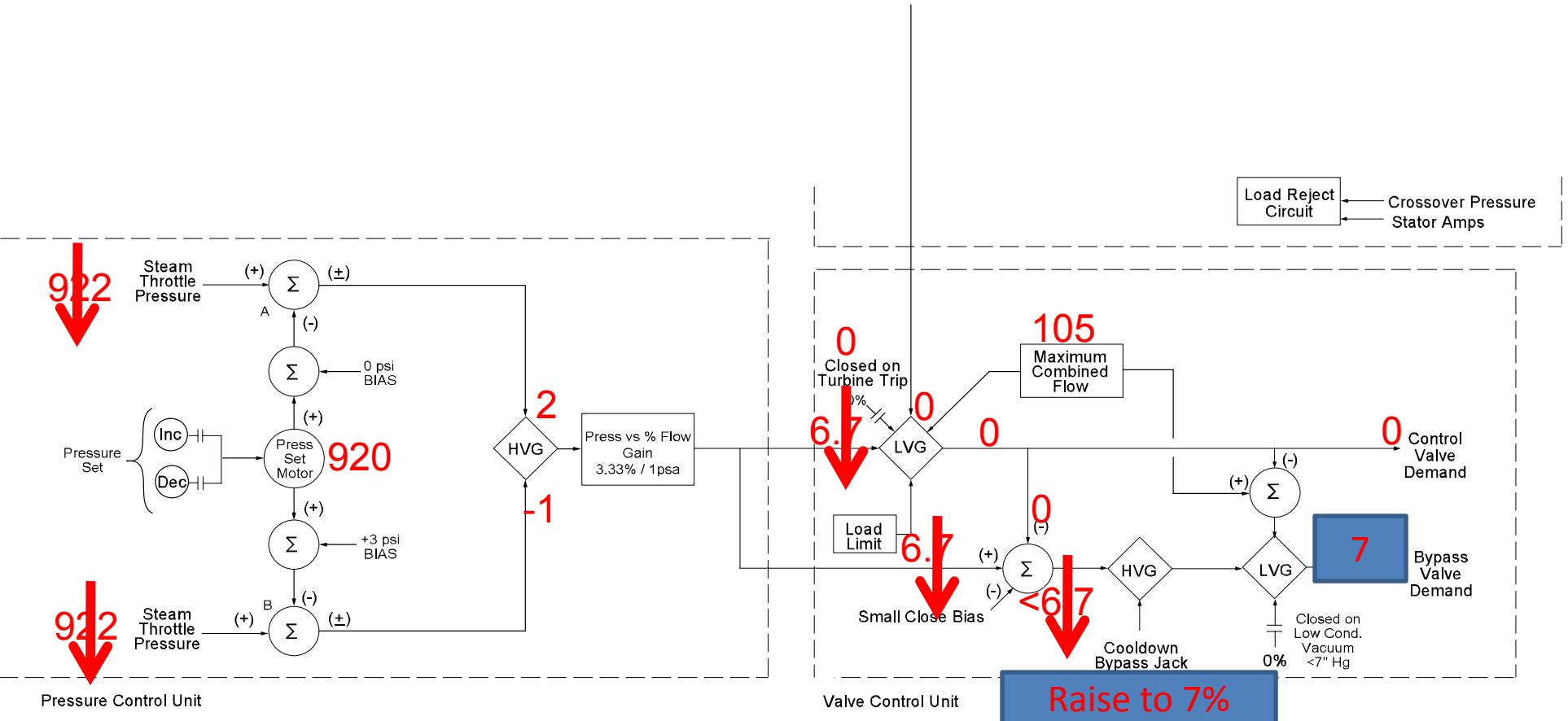


REACTOR POWER REDUCTION FROM 100% TO 80% Figure 3.2-1



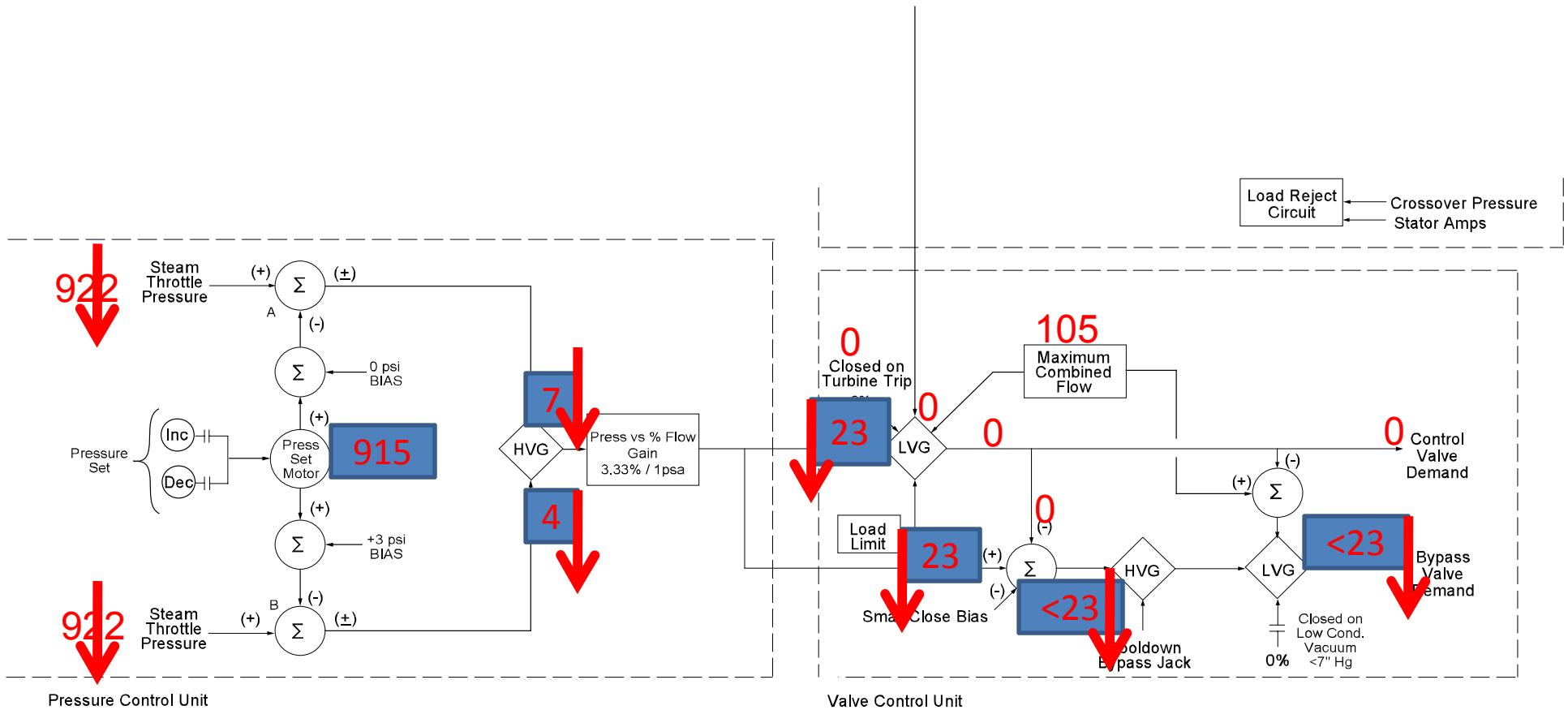
TURBINE SHUTDOWN FROM 20% REACTOR POWER

Figure 3.2-1



PLANT COOLDOWN WITH THE BYPASS JACK

Figure 3.2-1



PLANT COOLDOWN WITH PRESSURE SET

Figure 3.2-1

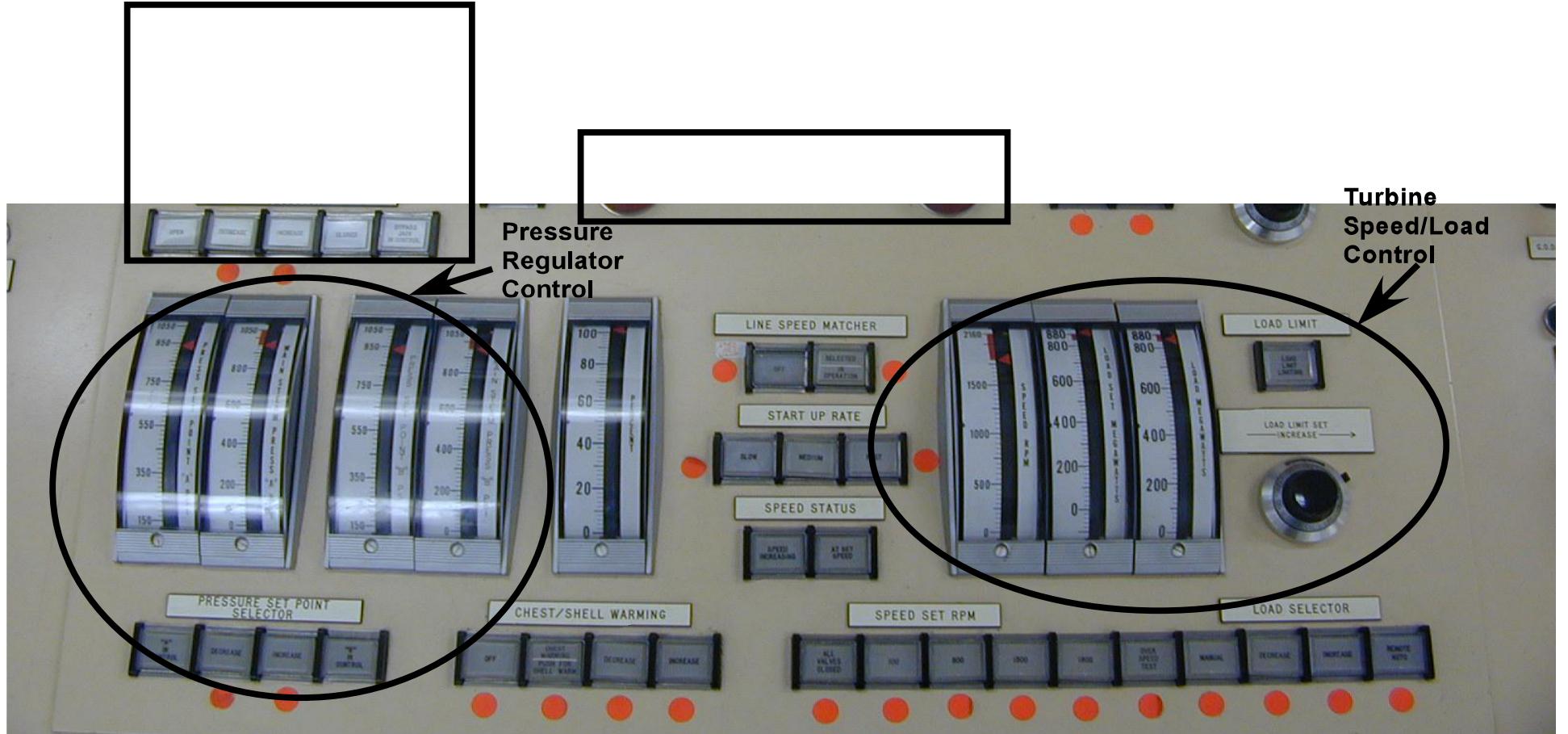


Figure 3.2-3

SYSTEM INTERFACES

- Main Steam
 - EHC controls TSV, TCV, BPV, ISV, ICV positions
 - Main Steam provides EHC sensed pressure input
- Condensate/Feedwater
 - EHC causes extraction non-return valve closure on a turbine trip.
 - BPV's are interlocked closed at less than 7 inches mercury vacuum.
- Reactor Protection
 - RPS receives scram signals for TSV Closure and TCV Fast Closure from EHC
- Turbine Building Closed Loop Cooling
 - TBCLC cools the EHC hydraulic oil.

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